МИНИСТЕРСТВО НА ОБРАЗОВАНИЕТО И НАУКАТА НА РЕПУБЛИКА БЪЛГАРИЯ
КИРИЛО-МЕТОДИЕВСКИ НАУЧЕН ЦЕНТЪР ПРИ БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ
ИЖЕВСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ ИМ. М. Т. КАЛАШНИКОВА
НАУЧНОЕ СООБЩЕСТВО “ПИСЬМЕННОЕ НАСЛЕДИЕ”
DIGITAL MEDIEVALIST SCHOLARLY COMMUNITY
ФОНДАЦИЯ „УСТОЙЧИВО РАЗВИТИЕ НА БЪЛГАРИЯ “

Писменото наследство и информационните технологии

El’Manuscript–2014

Материали от V международна научна конференция
Варна, 15–20 септември 2014 г.

София · Ижевск
2014

Сборникът е издаден с финансовата подкрепа на Министерството на образованието и науката на Република България по процедура за подкрепа на международни научни форуми.

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Писменото наследство и информационните технологии [Текст] : материали от V международна науч. конф. (Варна, 15–20 септември 2014 г.) / отг. ред. В. А. Баранов, В. Желязкова, А. М. Лаврентьев. — София ; Ижевск, 2014. — 448 с.

Сборникът съдържа материали от конференция, посветена на разработването и създаването на съвременни средства за съхраняване, описване, обработка, анализ и публикуване на ръкописни и старопечатни книжовни паметници и исторически извори, а също и на въпросите за подготвянето на електронни ресурси в областта на хуманитаристиката и тяхното използване в научните изследвания и преподаването.

ISBN 978–954–9787–25–2

The Centre of Image and Material Analysis in Cultural Heritage (CIMA) in Vienna and its Present Activities

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Damaged manuscripts, multispectral imaging, image enhancement, material analysis, XRF, rFTIR, Raman

This paper presents the activities of CIMA, the new interuniversity Centre of Image and Material Analysis in Cultural Heritage. Established in Vienna at the beginning of 2014, CIMA is an interdisciplinary center for research by philologists, computer scientists and chemists on multispectral imaging and analysis as well as the material analysis of cultural objects. Presently the focus of CIMA is on (predominantly damaged) medieval manuscripts. The main objective is to apply and develop new methods for non-invasive investigations, classify their results and make new scientific findings.

This paper reports on the present activities of CIMA, an interuniversity *Centre of Image and Material Analysis in Cultural Heritage* founded at the beginning of 2014 in the framework of the HRSM[1] project "Analysis and Conservation of Cultural Heritage—Modern Imaging and Material Analysis Methods for the Visualization, Documentation and Classification of Historical Written Material (Manuscripts)". Specializing in research in the fields of imaging, image enhancement and analysis as well as the non-invasive chemical analysis of the materials used for the production of historical objects, CIMA represents a unique facility with an interdisciplinary approach to the investigation of cultural heritage. CIMA brings together the expertise of three disciplines from three universities: philology (University of Vienna), computer Science (Vienna University of Technology) and chemistry (Vienna Academy of Fine Arts). Since the partners involved can already look back on several years of successful cooperation in the relevant field (primarily in the Austrian Science Fund project "The Sinaitic Glagolitic Sacramentary (Euchologium) Fragments" and its follow-up project "The Enigma of the Sinaitic Glagolitic Tradition"), the main idea behind the foundation of CIMA was to prolong and intensify this cooperation by establishing a central laboratory offering its services to universities, libraries, museums, exhibitions etc.

[1] "HRSM" refers to the Hochschulraum-Strukturmittel ("Structural Fund for Austrian Higher Education"), the higher education plan for 2013 of the Austrian Federal Ministry of Science and Research.

Using modern technologies, the manuscript activities aim to acquire new and improved data about already known historical sources, on the one hand, and to improve the equipment and methods of investigation, on the other. In the course of the project, a common database will be implemented which contains the information gained from the imaging, image enhancement and chemical and philological investigations. The final objective of the research is to compare the data gained to reveal correlations within data stemming from multiple modalities and, in general, to make new scholarly and scientific findings.

The manuscripts investigated by CIMA originate from the Middle Ages and are written in different languages and scripts. At present mainly Slavic, Greek and Latin parchment manuscripts and palimpsests from the Austrian National Library and various Austrian monasteries dating from the 8th until the 14th century are being analyzed. Apart from richly decorated codices, the experts of the CIMA are focusing primarily on poorly preserved objects and manuscripts containing overwritten text (palimpsests) in order to create comprehensive documentation of such manuscripts for the near future and next generation. It goes without saying that these manuscripts pose particular challenges to the philological decipherment.

In order to raise the visible contrast of such faded historical documents, multispectral imaging (MSI) is used. The manuscripts are examined with a portable MSI acquisition system containing two different cameras: a Hamamatsu C9300–124 near-infrared (NIR) grayscale camera and a Nikon D2Xs single-lens reflex (SLR) camera. The SLR camera is used for white light images and ultraviolet (UV) fluorescence images. The lighting is provided by two LED panels which enable imaging in 11 narrowband spectral ranges.

The imaging in narrow spectral ranges leads to enhancement of the contrast of degraded characters in a manuscript compared to white light illumination (e.g., faded script is usually most visible in UV fluorescence images). This is because parchment fluoresces under UV light, whereas iron-gall ink attenuates the UV light. Hence, the contrast between the characters and the remaining background regions is increased under UV illumination, compared to white and red light. The MSI approach has proven its applicability for the investigation of ancient and problematic sources since it is a non-invasive analysis tool capable of increasing the legibility of indecipherable text. Nevertheless, due to their bad condition, some manuscript portions still remain unreadable.

Thus, in order to further increase the contrast of the degraded characters, several enhancement techniques are applied: Principal Component Analysis (PCA), Independent Component Analysis (ICA) and Linear Discriminant Analysis (LDA). The details of these techniques will be described in the paper.

Such dimension reduction techniques are used to lower the third dimension of the multispectral scan in order to extract the relevant information, which is in our case the handwriting. Thus, for manuscripts containing only a single writing, the MSI scans are reduced to just one image to emphasize the ancient text. For palimpsests, on the other hand, the third dimension of the MS scan is reduced to two images emphasizing the two different layers of texts.

Another research topic of CIMA is document image analysis for degraded documents. In the course of the previous projects, document analysis methods were developed for optical character recognition (OCR), writer identification and layout analysis, to name just the most important.

The material investigations aim at the determination of the inks and pigments used for writing and illuminating, in contrast to the support of the manuscripts (presently the focus is on parchment). For this purpose, a non-destructive and non-invasive analysis is required—i.e., no alterations can occur on the manuscripts during or after the procedure. From a number of different options X-ray fluorescence analysis (XRF) has been chosen first. Experiences made during the two Austrian Science Fund projects have shown that the XRF analysis can deliver valuable information about the materials used in the codices since most of the pigments used for colouring consist of elements such as iron, lead or copper (Miklas, Gau et al. 2008).

Manuscripts are analysed under ambient environmental conditions. XRF in air is limited by the fact that only elements with an atomic number above 16 (sulphur) can be detected with sufficient reproducibility. Thus, only the inorganic components could be determined. In many cases, also organic materials consisting primarily of carbon, oxygen and nitrogen play an important role. For their identification, compound-specific information is necessary. Therefore, in addition to XRF, which gives an overview of the elemental compositions of the pigments and inks used, compound specific methods such as Ultraviolet-Visible (UV-Vis), Fourier Transform Infrared (FTIR) and Raman spectroscopy are also applied. While such a UV-Vis spectrometer could be obtained, a FTIR spectrometer had to be designed by ISTA in cooperation with and built by the German company Bruker Optics. Recently it has been tested for the non-destructive analysis of pigments as well as organic materials. These results will be accomplished by investigations made possible by the acquisition through the HRSM-project of a portable Raman spectrometer. These investigations increase our knowledge of the materials applied in the manuscripts in various regions and periods.

Literature

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